

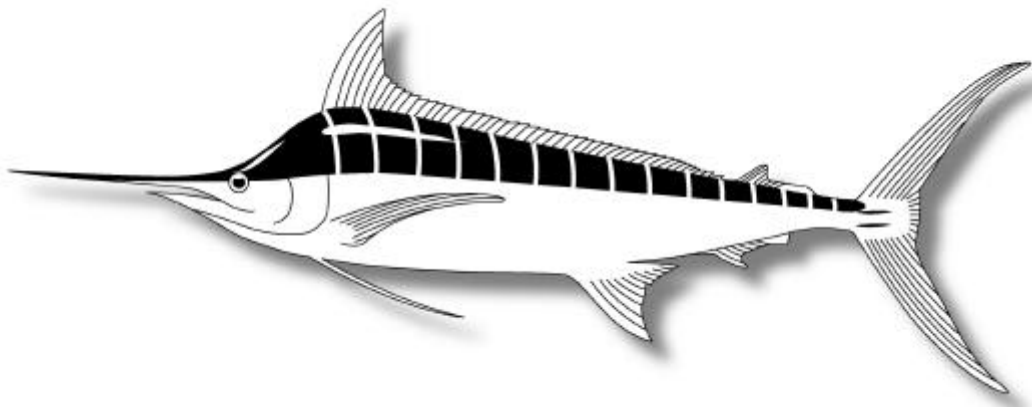


SCTB13 Working Paper

## **BBRG-1**

**Interactive Session on billfish:  
An update for the year 2000:  
Present knowledge, current and future research.**

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## **Interactive Session on billfish: An update for the year 2000: Present knowledge, current and future research.**

**Objective:** To review/tabulate current billfish research and monitoring, identify information gaps and problems and suggest future work. Update the table annually and obtain input from other organisations and countries.

**Methods:** The attached table is for discussion at the forthcoming SCTB. The intent is for participants to update this table prior to the meeting with relevant information. There are a lot of gaps in the table presented here. It is up to everyone to help update this table.

At present most of the information and proposed research work described here is SPC's – the intent is for other organisations to add their current and proposed research to this document so that it can be updated prior to the meeting. The intent is so all organisations and countries are kept abreast of current and proposed research. The intent of this table is to then allow the meeting to focus on present research shortcomings and to suggest future research priorities.

The table is intended to as a 'living document' - to be reviewed and updated each year and thereby providing a guide to current knowledge and future work.

Please provide whatever information you can and feel free to correct, add or delete any of the information I have put forward.

### **Considerations:**

- Data Requirements – Farman (1989) and Uozumi (1999) point out that much of the required data for assessment and management of the billfish stocks is presently insufficient or inadequate. Below is a potential list of the main data requirements to help estimate abundance and to assist in stock assessments;
  - Complete catch and effort statistics, including an estimate of total catch, spatial distribution of stock or stocks and standardization for the various fishing gears and techniques. This requires information on gear configuration that is available only from log sheets (probably not that accurate) or extensive observer programmes (deployment of hook monitors etc).
  - Recruitment can be estimated from age composition data so consequently validated age length data is required.
  - Yield per recruit analysis also requires weight at age and catch at age. Estimates of mortality may be obtained from length frequencies, age distribution of the catch, or tagging data – there is a paucity of all of this.
  - Knowledge of the vertical distribution of the species in relation to longline configuration – does this vary with abundance and environmental factors?

Species – Striped marlin

<b>Striped marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority / Requirements</b>
<b>Fishery (description &amp; importance)</b>				
<b>Commercial</b>	<ul style="list-style-type: none"> <li>• Are the 12th ranked species (relative occurrence) caught by commercial longliners (MHLC WP1 1999).</li> <li>• Unknown re commercial value, though the price in Japan has increased significantly over recent decades (Ueyanagi et.al. 1989).</li> <li>• Annual catch ~17,000 tonnes</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection</li> <li>• IATTC – ongoing catch and effort data collection</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection</li> <li>• IATTC –ongoing catch and effort data collection</li> </ul>	Catch and effort data
<b>Longline</b>	<ul style="list-style-type: none"> <li>• Pre-spawning striped marlin often fetch high prices on sashimi markets and are caught in the eastern areas of the WSP in the latter part of the year (Bailey, Williams &amp; Itano 1996).</li> <li>• Ward (1996) describes the Japanese longline fishery which sometimes targets striped marlin in eastern Australian waters.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC – ongoing catch and effort data collection.</li> <li>• IATTC – ongoing catch and effort data collection.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection.</li> <li>• IATTC – ongoing catch and effort data collection.</li> </ul>	Catch and effort data
<b>Pole-and-line</b>	<ul style="list-style-type: none"> <li>• Not caught (Bailey, Williams &amp; Itano 1996).</li> </ul>			
<b>Purse seine</b>	<ul style="list-style-type: none"> <li>• Only recorded rarely, though are more common in NZ EEZ (occur in 1.8% of sets; Bailey, Williams &amp; Itano 1996).</li> <li>• Annual PS catch described in IATTC annual reports</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection.</li> <li>• IATTC – ongoing catch and effort data collection, ecological and community associations</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection.</li> <li>• IATTC – ongoing catch and effort data collection.</li> </ul>	Catch and effort data
<b>Troll</b>	<ul style="list-style-type: none"> <li>• Seldom landed, occasional hookups – not significant (Bailey, Williams &amp; Itano 1996).</li> </ul>			Catch and effort data
<b>Recreational</b>	<ul style="list-style-type: none"> <li>• One of the main target gamefish species, where present (usually sub-tropical areas), especially NZ.</li> <li>• West (1990) and Campbell et al. (1996) Describe the recreational gamefishery in SE Australia, where striped marlin became the most common billfish catch during the 1990s.</li> <li>• Total recreational catch in the western and central pacific ~ 260 tonnes (Williams &amp; Whitelaw 2000).</li> </ul>	<ul style="list-style-type: none"> <li>• Good data collected by Aust gamefishing clubs. Some data to NSWFRRI. Others?</li> <li>• NZ - Good Wt data for 95% of recreational catch (NZ Big Game Fishing Council).</li> <li>• Annual Recreational CPUE indexes from charter skippers, (NZ Marine Research Foundation).</li> </ul>	<ul style="list-style-type: none"> <li>• SPC trying to coordinate data collection – all assistance appreciated.</li> <li>• Aust – analysis on impact of recreational catch on resource – BRS</li> <li>• IATTC – attempting data collection in EPO region.</li> </ul>	Historic and current catch and effort data
<b>Targeting</b>	<ul style="list-style-type: none"> <li>• 3 main fisheries; longline, purse seine, and sport</li> </ul>			Gear deployment

<b>Striped marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority / Requirements</b>
	fishing. <ul style="list-style-type: none"> <li>• Longline fishery sometimes targets this species specifically</li> <li>• purse seine not at all</li> <li>• Recreational all the time.</li> </ul>			descriptions i.e. hook depth/temp monitors – via observers?
<b>Data holdings</b>				
<b>Commercial (logbook, landings, observer)</b>	<ul style="list-style-type: none"> <li>• SPC Catch and effort data back to 1962, Observer data from 1994 (limited), unloading data (from 1993) (Anon 1998)</li> <li>• Data collected by observers on Japanese longliners in the eastern AFZ held by AFMA.</li> <li>• Size monitoring of catches landed by Australian longliners 1998? held by AFMA.</li> <li>• IATTC purse seine (back to 1989) and longline data back to 1952</li> </ul>	<ul style="list-style-type: none"> <li>• SPC (OFP section) is responsible for compiling regional tuna fisheries data. (Anon 1998).</li> <li>• IATTC monitoring purse seine and longline in eastern Pacific.</li> </ul>	SPC will continue carrying out this activity; AFMA plans to continue size monitoring. IATTC verifying logbooks via observers on purse seiners	Ongoing logbooks. Observer data urgently required
<b>Recreational</b>	<ul style="list-style-type: none"> <li>• Some holdings within national gamefishing clubs (limited and disjointed), Aust, NZ &amp; US good.</li> <li>• Good Wt data for 95% of recreational catch for Bay of Islands Swordfish Club New Zealand since 1924 (NZ Big Game Fishing Council). Also good data in Australia.</li> <li>• Some holdings by national fisheries management bodies (even more limited).</li> <li>• West (1991) provides estimates of catches by recreational anglers in eastern Australian in 1989.</li> <li>• Pepperell collected data from tournaments (1993?–present) – data @ NSWFR I</li> </ul>	<ul style="list-style-type: none"> <li>• SPC trying to coordinate holdings onto SPC database (preliminary stages)</li> <li>• CSIRO &amp; Pepperell collating some historical charter boat data for NE Australia</li> <li>• IATTC have proposal for data collection programme.</li> </ul>	SPC wanting to coordinate with IGFA and gamefishing clubs to standardise data – ‘log sheet’. Data entry?	Needs expanding and linking with IGFA, Billfish Foundation, IATTC, SPC etc
<b>Research (e.g. tagging, length-weight data sets)</b>	<ul style="list-style-type: none"> <li>• SPC - length frequency &amp;/or weight data from 1991 (port sampling and observers) – total number 4,581. (SPC data)</li> <li>• NSW Gamefish Tagging Program (1973–present).</li> <li>• Pepperell – historic &amp; current wt data</li> <li>• IATTC length frequency data from purse seiners from 1989 to present.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC - ongoing</li> <li>• NSW Gamefish Tagging Program – ongoing.</li> <li>• NMFS – ongoing</li> <li>• IATTC cooperative project with Japan, including stock assessments and relationships to other species and oceanic conditions.</li> </ul>	SPC – ongoing IATTC - ongoing	Pop-up archival tags and ongoing conventional tagging.

<b>Striped marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority / Requirements</b>
<b>Biological</b>				
<b>Age and growth</b>	<ul style="list-style-type: none"> <li>• <b>No validated age analyses</b> (Radtke 1983; Davie &amp; Hall 1990). Aged to 9 years?</li> <li>• Little sexual dimorphism in growth.</li> <li>• Growth slows with age (Ueyanagi &amp; Wares 1975). Young fish ~30cm/year, old fish ~ 13cm/year.</li> <li>• Length weight relationship for NZ recreational catch (NZBGFC records). L/W analysis by Pepperell (Aust).</li> </ul>	<ul style="list-style-type: none"> <li>• SPC presently carrying out a study for to determine the feasibility of ageing fish from dorsal and/or anal spines.</li> </ul>	SPC? Others?	Validate age analysis
<b>Maturation &amp; spawning (location, period, size &amp; age at maturity, fecundity, sex ratio)</b>	<ul style="list-style-type: none"> <li>• Egg distribution unknown.</li> <li>• Some larvae work carried out (Squire &amp; Suzuki 1990).</li> <li>• Seasonal spawning in early summer?</li> <li>• Females reach sexual maturity @ 23-36kg (Hanamoto 1977) – age ?</li> <li>• Thought to spawn once per season (Pillai &amp; Ueyanagi 1978).</li> <li>• Unknown as to whether they are batch or serial spawners</li> <li>• Spawning areas not fully known.</li> <li>• Fecundity ?</li> </ul>	IATTC validated GI to allow correct interpretation of available data.	Histological work required.	Spawning areas better defined. Fecundity studies Age at maturity
<b>Diet</b>	<ul style="list-style-type: none"> <li>• Feed on pelagic species, mostly in morning (Ueyanagi &amp; Wares 1975) and epipelagic species (Nakamura 1985).</li> <li>• Food of marlins from NZ waters(Baker, A.N. 1966).</li> <li>• Almost any species of suitable size may be taken, tend to take one or two species only on any particular day (Saul 1984)</li> </ul>	<ul style="list-style-type: none"> <li>• SPC – examined some stomachs collected by SPC observers</li> <li>• IATTC diet studies and community analysis showing differences among marlin species.</li> </ul>	SPC minimal – ongoing. IATTC - ongoing	Dietary studies required for ecological and species associations.
<b>Movement</b>	<ul style="list-style-type: none"> <li>• Little known</li> <li>• tagging shows some extensive and limited horizontal movement around Hawaii and from California to Hawaii (Holts &amp; Prescott 1994-8), also around Australia (n=2) and extensive movements to the north of NZ (Henry and Thompson 1998; (Holdsworth and Saul 1998; Davies and Hartill 1998 and Hartill and Davies, in prep).</li> <li>• Vertical movement – ultrasonic telemetry (Brill</li> </ul>	<ul style="list-style-type: none"> <li>• Ongoing tagging by game fishers in Australia, NZ &amp; USA. Some tagging carried out by island gamefishing clubs.</li> </ul>	<ul style="list-style-type: none"> <li>• Ongoing recreational tagging; Australia, NZ &amp; USA – some carried out by island gamefishing clubs.</li> <li>• More analysis required!</li> <li>• Pop-up satellite</li> </ul>	Pop-up archival tags required. On-going conventional tagging.

<b>Striped marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority / Requirements</b>
	et.al. 1993; Holland, Brill & Chang 1990). Fish spend much time near surface. Mostly in waters 25-27 <sup>0</sup> C, though reportedly in cooler waters off California.		tags? • Observer tagging?	
<b>Mortality</b>	<ul style="list-style-type: none"> <li>• <b>Unknown.</b></li> </ul>	<ul style="list-style-type: none"> <li>• Ongoing conventional recreational tagging - minimal. (NSWFR, NMFS, NIWA)</li> </ul>	?	
<b>Other:</b>				
<b>Tagging-related mortality and tag loss</b>	<ul style="list-style-type: none"> <li>• Unknown mortality – differing results</li> <li>• potentially high tag-loss</li> <li>• tag reporting rates probably low.</li> </ul>	?	?	Sonic tracking and pop-up archival tags – recreational and commercial.
<b>Survival of longline-caught fish</b>	<ul style="list-style-type: none"> <li>• Small amount of observer data from NZ (Francis et al 1999) – also other countries.</li> <li>• SPC observer data shows, for the WteP, WSP and WTP respectively, a 54, 41 and 42% mortality of longline caught fish.</li> </ul>	?	?	Observer data and analysis.
<b>Stock</b>				
<b>Assessment</b>	<ul style="list-style-type: none"> <li>• Shomura 1980<sup>1</sup> and Skillman 1989<sup>2</sup> suggest Pacific stock had a MSY of 24,000mt<sup>1</sup> and in good condition<sup>2</sup></li> </ul>	IATTC assessment in cooperation with Japan – by spring 2001	Needs updating – looking at ‘core’ areas.	Update required with biological parameters refined.
<b>Structure</b>	<ul style="list-style-type: none"> <li>• most recent work, based on mtDNA (Graves and McDowell 1997) identified 3 stocks</li> <li>• previous studies suggested single stock or 2 stocks separated at the equator (Bartoo &amp; Ueyanagi 1980). Squire &amp; Suzuki (1990) suggested single stock with ‘semi-independent subpopulations’</li> <li>•</li> </ul>	?	DNA study?	Verification of genetic studies?
<b>Stock size – Catch and CPUE trends</b>	<ul style="list-style-type: none"> <li>• Stock size <b>unknown.</b></li> <li>• Total catch decreased from 40,000 tonnes in 1960’s to ~ 15,000 tonnes in 80’s and 90’s, now fairly stable (Williams, Bigelow &amp; Whitelaw 1999)</li> <li>• CPUE decreased from 0.18 fish/100hooks to present value of .04 (SPC database).</li> <li>• Fishing strategies have also altered over time – more deep fishing, possibly more so in the tropics.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection.</li> <li>• Commercial and recreational data collected in Aust, NZ and US, though there are now problems due to ‘no retention’ laws.</li> <li>• IATTC – data collection and analysis.</li> </ul>	SPC –ongoing catch and effort data collection. Look at core areas IATTC – stock assessment and structure	Verification of log book data by observers for commercial vessels. Improvement of game fish catch and effort data.

<b>Striped marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority / Requirements</b>
<b>Management</b>				
<b>Gear restrictions</b>				Impetus from recreational groups increasing.
<b>Area restrictions</b>	<ul style="list-style-type: none"> <li>• Mexico – commercial restrictions.</li> <li>• Longline off NZ?</li> <li>• Restrictions around Hawaii</li> </ul>			Impetus from recreational groups increasing.
<b>Catch limits</b>	<ul style="list-style-type: none"> <li>• Commercial fishers are not permitted to keep marlin in the New Zealand EEZ.</li> <li>• No marlin retained off California</li> </ul>			Impetus from recreational groups increasing.
<b>Size restrictions</b>	<ul style="list-style-type: none"> <li>• NZ - Voluntary Recreational min. size of 90kg.</li> <li>• voluntary size or retention restrictions in Australia for recreational fishermen (80kg).</li> </ul>			Impetus from recreational groups increasing.

#### Species – Blue marlin

<b>Blue marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Fishery (description &amp; importance)</b>				
<b>Commercial</b>	<ul style="list-style-type: none"> <li>• Are the 6th ranked species (relative occurrence) caught by commercial longliners (MHLC WP1 1999).</li> </ul>	<ul style="list-style-type: none"> <li>• Ongoing – SPC, IATTC, AFMA data collection.</li> </ul>		Catch and effort data
<b>Longline</b>	<ul style="list-style-type: none"> <li>• Is a by-catch of the longline fleets.</li> <li>• Highest catch rates occur around northern waters of the Marshall Islands though they show a preference for warmer offshore waters of the WTP and northern areas of WSP (warm pool; Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>• Ongoing – SPC, IATTC, AFMA data collection.</li> </ul>	Need for better identification	Catch and effort data
<b>Pole-and-line</b>	<ul style="list-style-type: none"> <li>• Not caught (Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>• Ongoing – SPC, IATTC, AFMA data collection.</li> </ul>		
<b>Purse seine</b>	<ul style="list-style-type: none"> <li>• Occur in 1.2% of sets in NZ EEZ</li> <li>• are common (1-10 per set) in the WTP (Bailey, Williams &amp; Itano 1996).</li> <li>• These are the most often caught billfish in purse seine sets.</li> </ul>	<ul style="list-style-type: none"> <li>• Ongoing – SPC, IATTC, AFMA data collection.</li> </ul>		Catch and effort data

<b>Blue marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Troll</b>	<ul style="list-style-type: none"> <li>Seldom landed (Bailey, Williams &amp; Itano 1996), though are landed and sold in Hawaii.</li> </ul>	<ul style="list-style-type: none"> <li>Ongoing – SPC, IATTC, AFMA data collection.</li> </ul>		Catch and effort data
<b>Recreational</b>	<ul style="list-style-type: none"> <li>Major recreational fishery throughout the Pacific, especially Hawaii, east coast Australia, PNG, Micronesia.</li> <li>Total annual recreational catch is around 616 tonnes (Williams &amp; Whitelaw 2000).</li> </ul>			Historic and current catch and effort data
<b>Targeting</b>	<ul style="list-style-type: none"> <li>Within the WCPO there are three main fisheries which blue marlin can recruit to, being; a) longline, b) purse seine and c) sport fish.</li> <li>It is only the sport fish fishery, which actually targets this species, both of the other fisheries only catch blue marlin as a by-catch.</li> <li>Quite often, especially if small, the fish are not retained or included on commercial log sheets.</li> <li>The average size of fish caught by longline in the WCPO is 184cm.</li> <li>It is thought that fish caught in purse seines are smaller, usually males.</li> </ul>			Gear deployment descriptions i.e. hook depth/temp monitors – via observers?
<b>Data holdings</b>				
<b>Commercial (logbook, landings, observer)</b>	<ul style="list-style-type: none"> <li>SPC Catch and effort data back to 1962,</li> <li>Observer data from 1994 (limited),</li> <li>unloading data (from 1993) (Anon 1998)</li> <li>IATTC purse seine and longline data back to?</li> </ul>	<ul style="list-style-type: none"> <li>SPC/OFP is responsible for compiling regional tuna fisheries data for SPC area (Anon 1998).</li> <li>IATTC monitoring purse seine and longline in eastern Pacific.</li> </ul>	SPC and IATTC will continue this activity	Ongoing logbooks. Observer data urgently required
<b>Recreational</b>	<ul style="list-style-type: none"> <li>Some holdings within national gamefishing clubs (limited and disjointed).</li> <li>Some holdings by national fisheries management bodies (even more limited)</li> </ul>	<ul style="list-style-type: none"> <li>SPC trying to coordinate holdings onto SPC database (preliminary stages).</li> <li>NSWFRI – ongoing</li> <li>Pepperell</li> <li>IATTC have proposal for data collection programme.</li> <li>WPRFC set up a ‘Recreational Fisheries data task force’.</li> </ul>	SPC wanting to coordinate with IGFA and gamefishing clubs to standardise data – ‘log sheet’.	Needs expanding and linking with IGFA, Billfish Foundation, IATTC, SPC etc

<b>Blue marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Research (e.g. tagging, length-weight data sets)</b>	<ul style="list-style-type: none"> <li>• SPC - length frequency &amp;/or weight data from 1991 (port sampling and observers) – total number 10,961. (Anon 1998).</li> <li>• NSW Gamefish Tagging Program (1973–present)</li> <li>• IATTC – length frequency data from purse seiners from 1989 to present.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC – ongoing</li> <li>• NSWFRI</li> <li>• NMFS</li> <li>• Hawaii Conservation Association plan to deploy 6 pop-up archival tags off Hawaii in June 2000.</li> <li>• IATTC – cooperative project with Japan including stock assessment and relationships to other species and oceanic conditions.</li> </ul>	SPC – ongoing NSWFRI NMFS Aust study on impact of recreational fishing on resource	Pop-up archival tags and ongoing conventional tagging.
<b>Biological</b>				
<b>Age and growth</b>	<ul style="list-style-type: none"> <li>• <b>No validated age work.</b></li> <li>• Indications they can live to 30 years (Hill et al. 1989; Nakamura 1985; Wilson et. al. 1991).</li> <li>• Daily ageing study in Atlantic.</li> <li>• Growth - sexually dimorphic. Growth rate of females remains fairly constant to around 360cm, males appear to plateau at around 230cm.</li> <li>• Sex-related size differences are related to differential growth and not due to differential mortality (Wilson et al. 1991).</li> </ul>	<ul style="list-style-type: none"> <li>• SPC presently carrying out a study for to determine the feasibility of ageing fish from dorsal and/or anal spines.</li> <li>• Others?</li> </ul>	SPC?	Validate age analysis
<b>Maturation &amp; spawning (location, period, size &amp; age at maturity, fecundity, sex ratio)</b>	<ul style="list-style-type: none"> <li>• Spawning not properly documented, believed to occur year-around in equatorial waters (10°S - 20°N) and during summer periods in the southern (10°S - 30°S) and northern (20°N - 30°N) hemispheres, though others, notably Nishikawa et.al. (1985) and Hopper (1990) have questioned the concept of year around spawning.</li> <li>• Howard and Ueyanagi (1965) suggest that peak concentrations of spawning fish probably occur around Micronesia in the northwest and French Polynesia in the southeast.</li> <li>• Appear to be determinate, serial spawners. Females may spawn a number of times during the spawning season.</li> <li>• Preliminary estimates of total reproductive output (Hopper 1990) range from 31.5 million (female; 127kg)</li> </ul>	<ul style="list-style-type: none"> <li>• IATTC – validated GI for historical data and use ID of spawning areas.</li> </ul>		Spawning areas better defined. Fecundity studies Age at maturity

<b>Blue marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
	to 98.9 million eggs (female; 420kg). <ul style="list-style-type: none"> <li>Size at maturity for females is around 80kg (Hopper 1990) and for males around 31kg. Kume and Joseph (1969), report for the eastern Pacific, that females may mature at 47kg and males at 35kg.</li> </ul>			
<b>Diet</b>	<ul style="list-style-type: none"> <li>Not a lot of research carried out.</li> <li>Feeds in or near surface waters, sometimes in deep water also.</li> <li>Feeds on squid and tuna like species (Nakamura 1985).</li> </ul>			Dietary studies required for ecological and species associations.
<b>Movement</b>	<ul style="list-style-type: none"> <li>There have been long distance tag recoveries, which indicates that the species is potentially wide ranging (Holts and Prescott 1994-1998; TRCC 1999).</li> <li>Vertical movement shows that they prefer water temperatures in the range of 23-27°C (TRCC 1999, Graves et al. 1999).</li> </ul>		<ul style="list-style-type: none"> <li>Archival pop-up tags off Hawaii. Hawaii Conservation Association</li> </ul>	Further deployment of Pop-up archival tags in W & S Pacific. On-going conventional tagging.
<b>mortality</b>	<ul style="list-style-type: none"> <li>There is no estimate of natural or fishing mortality.</li> <li>Limited tag returns (&lt; 1%).</li> </ul>			
<b>Other</b>				
<b>Tagging-related mortality and tag loss</b>	<ul style="list-style-type: none"> <li>Tag related mortality unknown</li> <li>potentially high tag-loss,</li> <li>tag reporting rates probably low.</li> <li>Sonic tagging work showed good survival rate (Holland et al. 1990, Graves et al. 1999)</li> </ul>			Sonic tracking and pop-up archival tags – recreational and commercial.
<b>Survival of longline-caught fish</b>	<ul style="list-style-type: none"> <li>Around 60% alive after 12h on a longline (Berkeley &amp; Edwards 1998).</li> <li>SPC observer data shows, for the WteP, WSP and WTP respectively, a 100 (n=3), 64 and 47% mortality of longline caught fish.</li> </ul>			Observer data and analysis.
<b>Stock Status</b>				
<b>Assessment</b>	<ul style="list-style-type: none"> <li>Earlier stock assessments (Yuen and Miyake 1978), suggested stock had been substantially over-fished since the early 1960s.</li> <li>CPUE has decreased from around 0.3 fish per 100 hooks in the 1950's to 0.08 in 1995.</li> <li>Skillman (1990) fitted a surplus production model to adjusted catch and effort data (1952-1980) and concluded that the stock is overfished.</li> </ul>	<ul style="list-style-type: none"> <li>Australia – BRS &amp; CSIRO? Presently carrying out assessments for blue marlin in Australian waters.</li> </ul>		Scientific collaboration on available assessments including input from both commercial and game fishing sources.

<b>Blue marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
	<ul style="list-style-type: none"> <li>• More recent work (IATTC, 1999) suggests stock is in a healthy position</li> </ul>			
<b>Structure</b>	<ul style="list-style-type: none"> <li>• Recent work indicates a single stock (Graves &amp; McDowell (1995)</li> <li>• Is the most tropical of the billfish species.</li> <li>• Some assume one stock for the Pacific (Suzuki 1989) and that the populations in the Pacific and Indian oceans are separate (Shomura 1993).</li> <li>• There have been long distance tag recoveries, which indicate that the species is wide ranging (Holts &amp; Prescott 1994-1998; TRCC 1999).</li> </ul>			Further Genetic verification required?
<b>Stock size – Catch and CPUE</b>	<ul style="list-style-type: none"> <li>• Stock size unknown.</li> <li>• Taken mainly in tropical oceanic waters.</li> <li>• Catch shows some fluctuations and is presently around 16,000 tonnes.</li> </ul>	IATTC assessment in 1999 and 2000 – further model development by 2001.		Verification of log book data by observers for commercial vessels. Improvement of game fish catch and effort data.
<b>Management</b>				
<b>Gear restrictions</b>				Impetus from recreational groups increasing.
<b>Area restrictions</b>				Impetus from recreational groups increasing.
<b>Catch limits</b>	<ul style="list-style-type: none"> <li>• Commercial fishers are not permitted to keep fish in the New Zealand and Australian EEZ. Recreational bag limits in some Australian states.</li> <li>• Mexico?</li> <li>• No commercial landings in California</li> </ul>			Impetus from recreational groups increasing.
<b>Size restrictions</b>	<ul style="list-style-type: none"> <li>• Voluntary minimum size for retention for gamefishing in Australia (80kg).</li> </ul>			Impetus from recreational groups increasing.

Species – **Black marlin**

<b>Black marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Fishery (description &amp; importance)</b>				
<b>Commercial</b>	<ul style="list-style-type: none"> <li>• Are the 14th ranked species (relative occurrence) caught by commercial longliners (MHLC WP1 1999).</li> <li>• Unknown commercial value – supposedly quite low.</li> <li>• Sold as sashimi in Japan.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection, also Australia (AFMA), NZ (NIWA) and IATTC.</li> </ul>		Catch and effort data
<b>Longline</b>	<ul style="list-style-type: none"> <li>• Potentially there is some over-reporting (mis-identification with blue marlin) from some fleets.</li> <li>• Caught more coastal.</li> <li>• Usually not targeted - catches around 1-2 fish per 10,000 hooks in WSP (Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection, also Australia (AFMA), NZ (NIWA) and IATTC.</li> </ul>		Catch and effort data
<b>Pole-and-line</b>	<ul style="list-style-type: none"> <li>• Not caught (Bailey, Williams &amp; Itano 1996).</li> </ul>			
<b>Purse seine</b>	<ul style="list-style-type: none"> <li>• Occur in 1% of sets in NZ EEZ;</li> <li>• Rare in WTP (&lt;1/set; Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection, also Australia (AFMA), NZ (NIWA) and IATTC.</li> </ul>		Catch and effort data
<b>Troll</b>	<ul style="list-style-type: none"> <li>• Seldom landed - occasionally hooked (Bailey, Williams &amp; Itano 1996).</li> <li>• Is some artisanal fishing, especially in PNG, Kiribati and Solomons.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC –ongoing catch and effort data collection, also Australia (AFMA), NZ (NIWA) and IATTC.</li> </ul>		Catch and effort data
<b>Recreational</b>	<ul style="list-style-type: none"> <li>• One of the main target gamefish species, where present (especially in Australia). A multi-million \$ industry.</li> <li>• Total annual game-catch ~ 518 tonnes (Williams &amp; Whitelaw 2000)</li> </ul>	<ul style="list-style-type: none"> <li>• Data collected by gamefishing clubs in Australia.</li> <li>• Project underway – NSWFR? </li> </ul>		Historic and current catch and effort data
<b>Targeting</b>	<ul style="list-style-type: none"> <li>• Are only targeted by recreational fishermen and some artisanal fishermen.</li> <li>• Is a by-catch for commercial longline and purse seine fisheries.</li> </ul>			Gear deployment descriptions i.e. hook depth/temp monitors – via observers?
<b>Data holdings</b>				
<b>Commercial (logbook, landings, observer)</b>	<ul style="list-style-type: none"> <li>• SPC catch and effort data back to 1962,</li> <li>• SPC observer data from 1994 (limited),</li> <li>• unloading data (from 1993; Anon 1998)</li> <li>• IATTC purse seine and longline data back to??</li> </ul>	<ul style="list-style-type: none"> <li>• SPC/OFP is responsible for compiling regional tuna fisheries data. (Anon 1998).</li> <li>• IATTC monitoring purse</li> </ul>	<ul style="list-style-type: none"> <li>• SPC &amp; IATTC will continue carrying out this activity</li> </ul>	Ongoing logbooks. Observer data urgently required

<b>Black marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
		seine and longline in eastern Pacific.		
<b>Recreational</b>	<ul style="list-style-type: none"> <li>Some data holdings within national gamefishing clubs (very limited and disjointed).</li> <li>Some data holdings by national fisheries management bodies (even more limited).</li> </ul>	<ul style="list-style-type: none"> <li>SPC trying to coordinate holdings onto SPC database (preliminary stages).</li> <li>Ongoing data collection in Aust (East coast – Murphy et al. 1999), NZ and US.</li> <li>IATTC have proposal for data collection programme.</li> </ul>	<ul style="list-style-type: none"> <li>SPC wanting to coordinate with IGFA and gamefishing clubs to standardise data – ‘log sheet’.</li> </ul>	Needs expanding and linking with IGFA, Billfish Foundation, IATTC, SPC etc
<b>Research (e.g. tagging, length-weight data sets)</b>	<ul style="list-style-type: none"> <li>SPC - length frequency &amp;/or weight data from 1991 (port sampling and observers) – total number 4,767 (Anon 1998).</li> <li>NSWFRI tagging program</li> </ul>	<ul style="list-style-type: none"> <li>SPC – ongoing</li> <li>NSWFRI – ongoing</li> <li>CSIRO (Davis et al. 1999).</li> <li>NMFS – ongoing</li> <li>IATTC – cooperative project with Japan on stock assessments and relationships to other species and oceanic conditions.</li> </ul>	<ul style="list-style-type: none"> <li>SPC – ongoing</li> <li>Aust study on impact of recreational fishermen on resource.</li> </ul>	Pop-up archival tags and ongoing conventional tagging.
<b>Biological</b>				
<b>Age and growth</b>	<ul style="list-style-type: none"> <li>Some validated ageing carried out by AIMS for small fish (AIMS 1999).</li> <li>The maximum recorded total length is 448cm and 708kg (Nakamura, 1985).</li> <li>They show strong sexual dimorphism in growth - males rarely exceed 180kg.</li> <li>Juvenile growth rates is fast and appear to be the same for both sexes. Males slow at maturity while females continue; females reach around 450kg (1000 lb) after about 10 years (Williams unpl).</li> <li>Black marlin off eastern Australia shows the following presumed age-weight relationship: 1-year old fish average 15-20kg, 2-year-olds average 30kg, 3-year-olds average 50-55kg and 4-year olds average 70kg (length frequency analysis, Williams unpl.; Pepperell, 1990).</li> <li>Cyr et.al. (1990) provided unvalidated ages of black marlin up to 20 years.</li> </ul>	<ul style="list-style-type: none"> <li>AIMS (Speare &amp; Williams unpubl.) – OTC tagging study – results?</li> <li>Daily ageing of juveniles – Pepperell / NMFS</li> <li>SPC presently carrying out a study for to determine the feasibility of ageing fish from dorsal and/or anal spines.</li> </ul>	<ul style="list-style-type: none"> <li>Early growth rates derived from length frequency data - NSWFRI</li> </ul>	Validate age analysis
<b>Maturation &amp;</b>	<ul style="list-style-type: none"> <li>East Australian studies suggest a spawning area in</li> </ul>			Spawning areas better

<b>Black marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>spawning (location, period, size &amp; age at maturity, fecundity, sex ratio)</b>	<p>the Coral Sea during October- December.</p> <ul style="list-style-type: none"> <li>No identified spawning in EPO, but possible – only low sampling in EPO.</li> <li>Age at maturity remains uncertain though it appears that males mature around 3-4 years (60kg) while females mature around 4-5 years (70kg).</li> <li>No significant spawning observed in eastern Pacific (Williams unpl.)</li> </ul>			<p>defined (Observer GSI studies?).</p> <p>Fecundity studies</p> <p>Age at maturity</p>
<b>Diet</b>	<ul style="list-style-type: none"> <li>Tuna like fishes, scad, queenfish (Williams unpl.)</li> </ul>			Dietary studies required for ecological and species associations.
<b>Movement</b>	<ul style="list-style-type: none"> <li>Tag recaptures suggest that there is a high degree of mixing throughout the entire Pacific (Campbell et al. 1998) but it is important to verify this with genetic studies (currently underway – (Graves et.al.?).</li> <li>Black marlin are highly mobile but do not appear to follow clear migration routes (Pepperell 1990)</li> </ul>	<ul style="list-style-type: none"> <li>Genetic studies underway (Graves)</li> <li>Environmental factors influencing the activity of black marlin (AIMS).</li> <li>Movement from study of parasites (Speare 1994).</li> </ul>	AIMS – circulation model for the Coral Sea including environmental variables and fisheries data.	<p>Pop-up archival tags required.</p> <p>On-going conventional tagging.</p>
<b>Mortality</b>	<ul style="list-style-type: none"> <li>Unknown</li> </ul>			
<b>Other</b>				
<b>Tagging-related mortality</b>	<ul style="list-style-type: none"> <li>Unknown – tagging data insufficient</li> </ul>			Sonic tracking and pop-up archival tags – recreational and commercial.
<b>Survival of longline-caught marlin</b>	<ul style="list-style-type: none"> <li>~60% alive after 16 hours (Campbell et.al. 1998).</li> <li>SPC observer data shows, for the WteP, WSP and WTP respectively, a 100 (n=3), 71 and 50% mortality of longline caught fish.</li> </ul>			Observer data and analysis.
<b>Stock</b>				
<b>Assessment</b>	<ul style="list-style-type: none"> <li>Due to uncertainty in total catch figures and stock structure, there have been no attempts to fit production models or estimate MSY.</li> <li>Catch has been sustained between 1,000-2,000 tonnes since 1980..</li> <li>AIMS, on their web site, state that the stock is stable or recovering in recent years (AIMS 1999). This needs to</li> </ul>	IATTC/ Japan carrying out a stock assessment.		<p>Update required with biological parameters refined.</p> <p>Scientific collaboration on available assessments including input from both</p>

<b>Black marlin</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
	be verified.			commercial and game fishing sources.
<b>Structure</b>	<ul style="list-style-type: none"> <li>Suggestions of 3 stocks – SW Pacific, eastern Pacific and Indian Ocean.</li> <li>Potentially some fish move between the SW Pacific and Indian stock (AIMS 1999) – stocks linked?</li> </ul>			Verification of genetic studies?
<b>Stock size – Catch and CPUE trends</b>	<ul style="list-style-type: none"> <li>Catch has decreased slightly since 1980 while CPUE has remained fairly constant (Williams, Bigelow &amp; Whitelaw 1999).</li> </ul>		<ul style="list-style-type: none"> <li>Need to look at 'core' areas.</li> </ul>	Verification of log book data by observers for commercial vessels. Improvement of game fish catch and effort data.
<b>Management</b>				
<b>Gear restrictions</b>	<ul style="list-style-type: none"> <li>Domestic vessels (Australia) limited to 500 hooks in Coral Sea area.</li> </ul>			Impetus from recreational groups increasing.
<b>Area restrictions</b>	<ul style="list-style-type: none"> <li>Some areas closed to Australian fishermen in the Coral Sea.</li> <li>Some areas of AFZ closed to Japanese.</li> </ul>			Impetus from recreational groups increasing.
<b>Catch limits</b>	<ul style="list-style-type: none"> <li>Not allowed to be retained by commercial fishermen in Australia or NZ</li> </ul>			Impetus from recreational groups increasing.
<b>Size restrictions</b>	<ul style="list-style-type: none"> <li>Voluntary minimum size (80kg) of retention in Australia (recreational).</li> </ul>			Impetus from recreational groups increasing.

### Species – Sailfish

<b>Sailfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Fishery (descriptions &amp; importance)</b>				
<b>Commercial</b>	<ul style="list-style-type: none"> <li>Are the 13<sup>th</sup> ranked species (relative occurrence) caught by commercial longliners (MHLC WP1 1999). Total catch ~1,000 t/pa.</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC – ongoing catch and effort data, also AFMA (Australia) and</li> </ul>		Catch and effort data

<b>Sailfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
		NIWA (NZ).		
<b>Longline</b>	<ul style="list-style-type: none"> <li>Catch rates highest around NE Australia, PNG, Solomon's, Indonesia and the Philippines. Caught mostly closer to shores and reefs. Some data is not available e.g. Japan. Tend to occur in groups (Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC – ongoing catch and effort data, also AFMA (Australia) and NIWA (NZ).</li> </ul>		Catch and effort data
<b>Pole-and-line</b>	<ul style="list-style-type: none"> <li>Not caught (Bailey, Williams &amp; Itano 1996).</li> </ul>			
<b>Purse seine</b>	<ul style="list-style-type: none"> <li>Occur &lt;1 per set in WTP (Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC – ongoing catch and effort data, also AFMA (Australia) and NIWA (NZ).</li> </ul>		Catch and effort data
<b>Troll</b>	<ul style="list-style-type: none"> <li>Occasionally hooked, seldom landed (Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC – ongoing catch and effort data, also AFMA (Australia) and NIWA (NZ).</li> </ul>		Catch and effort data
<b>Recreational</b>	<ul style="list-style-type: none"> <li>Total annual game-catch ~ 235 tonnes (Williams &amp; Whitelaw 2000)</li> </ul>			Historic and current catch and effort data
<b>Targeting</b>	<ul style="list-style-type: none"> <li>Is targeted throughout the pacific as a gamefish</li> </ul>			Gear deployment descriptions i.e. hook depth/temp monitors – via observers?
<b>Data holdings</b>				
<b>Commercial (logbook, landings, observer)</b>	<ul style="list-style-type: none"> <li>SPC Catch and effort data back to 1962, Observer data from 1994 (limited), unloading data (from 1993) (Anon 1998)</li> <li>IATTC purse seine and longline data back to??</li> </ul>	<ul style="list-style-type: none"> <li>SPC (OFP) &amp; IATTC is responsible for compiling regional tuna fisheries data. (Anon 1998).</li> <li>IATTC monitoring purse seine and longline in eastern Pacific</li> </ul>	<ul style="list-style-type: none"> <li>SPC will continue carrying out this activity</li> </ul>	Ongoing logbooks. Observer data urgently required
<b>Recreational</b>	<ul style="list-style-type: none"> <li>Some holdings within national gamefishing clubs (very limited and disjointed). Some holdings by national fisheries management bodies (even more limited)</li> </ul>	<ul style="list-style-type: none"> <li>SPC to coordinating holdings onto SPC database (preliminary stages)</li> <li>IATTC have proposal for data collection programme.</li> </ul>	<ul style="list-style-type: none"> <li>SPC coordinating with IGFA and gamefishing clubs.</li> </ul>	Needs expanding and linking with IGFA, Billfish Foundation, IATTC, SPC etc
<b>Research (e.g. tagging, length-weight data sets)</b>	<ul style="list-style-type: none"> <li>SPC – length frequency &amp;/or weight data from 1991 (port sampling and observers) – total number 857. (Anon 1998)</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC – ongoing</li> <li>IATTC – cooperative project with Japan including stock assessment and relationships to other species and oceanic</li> </ul>	<ul style="list-style-type: none"> <li>SPC – ongoing</li> </ul>	Ongoing catch sampling Pop-up archival tags and ongoing conventional tagging.

<b>Sailfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
		conditions.		
<b>Biological</b>				
<b>Age and growth</b>	<ul style="list-style-type: none"> <li>Accurate age difficult to determine – apparently grow rapidly. 1y=183cm, 2y=216cm, 3y=234cm (Anon 1998). Maximum age estimated at 13-15y (Prince et.al 1986). Reach a maximum size around 100kg (Nakamura 1985)</li> </ul>	<ul style="list-style-type: none"> <li>SPC presently carrying out a study for to determine the feasibility of ageing fish from dorsal and/or anal spines.</li> <li>IATTC (NMFS) – work on otoliths, growth and morphometrics on larval and juveniles. Comparison of EPO and Atlantic.</li> </ul>		Validate age analysis
<b>Maturation &amp; spawning (location, period, size &amp; age at maturity, fecundity, sex ratio)</b>	<ul style="list-style-type: none"> <li>Are heterosexual – do not exhibit sexual dimorphism. Weight at first maturity for females as 13-18kg and males 10kg = 12-18 months (De Sylva &amp; Breder 1997). Appears to spawn all year, though more in summer (Nakamura 1985).</li> </ul>			Spawning areas better defined (Observer GSI studies?). Fecundity studies Age at maturity
<b>Diet</b>	<ul style="list-style-type: none"> <li>Can form feeding aggregations, diet tends to be broader than other billfish and includes herrings, pilchards, other baitfish also crustaceans and squid (ECTBAG 1994). Are fairly opportunistic feeders (WPRFMC 1998).</li> </ul>			Dietary studies required for ecological and species associations.
<b>Movement</b>	<ul style="list-style-type: none"> <li>Movements tend to be more localised than other species of billfish. Consequently there appears to be numerous isolated and semi isolated stocks (ECTBAG 1994).</li> <li>IATTC – in EPO movement is associated with changes of 28<sup>o</sup> SST isotherm</li> </ul>	<ul style="list-style-type: none"> <li>Movements derived from parasite study (Speare 1990, 1995).</li> </ul>		Pop-up archival tags required. On-going conventional tagging.
<b>mortality</b>	<ul style="list-style-type: none"> <li>unknown</li> </ul>			
<b>Other</b>				
<b>Tagging-related mortality</b>	<ul style="list-style-type: none"> <li>unknown</li> </ul>			Sonic tracking and pop-up archival tags – recreational and commercial.
<b>Survival of longline-caught fish</b>	<ul style="list-style-type: none"> <li>SPC observer longline data shows a 73 &amp; 64% mortality upon hauling for the WSP and WTP respectively.</li> </ul>			Observer data and analysis. Pop-up archival tags – sonic tracking

<b>Sailfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Stock Status</b>				
<b>Assessment</b>	<ul style="list-style-type: none"> <li>IATTC –outdated assessment</li> </ul>	IATTC with Japan.		Required with biological parameters refined. Scientific collaboration on available assessments including input from both commercial and game fishing sources.
<b>structure</b>	<ul style="list-style-type: none"> <li>Are more common near landmasses – higher levels of catch occur in coastal waters and close to islands and reefs (Campbell et.al 1998). Stock discrimination work using parasites has been attempted – no conclusion (Speare 1990)</li> </ul>			Verification of genetic studies?
<b>Stock size</b>	<ul style="list-style-type: none"> <li>Unknown</li> </ul>			Verification of log book data by observers for commercial vessels. Improvement of game fish catch and effort data.
<b>Management</b>				
<b>Gear restrictions</b>				Impetus from recreational groups increasing.
<b>Area restrictions</b>				Impetus from recreational groups increasing.
<b>Catch limits</b>				Impetus from recreational groups increasing.
<b>Size restrictions</b>				Impetus from recreational groups increasing.

Species – **Broadbill swordfish**

<b>Broadbill swordfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Fishery (descriptions &amp; importance)</b>				
<b>Commercial</b>	<ul style="list-style-type: none"> <li>Are the 7<sup>th</sup> most reported species from longline and constitute 2.1% of the catch by numbers (SPC database). Commercial value high – are targeted. Annual catch ~16,000 tonnes in the WP</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC - ongoing catch and effort data collection and AFMA (Australia) and NIWA (NZ).</li> </ul>	<ul style="list-style-type: none"> <li>SPC –ongoing catch and effort data collection</li> </ul>	
<b>Longline</b>	<ul style="list-style-type: none"> <li>BBL are mainly caught by longline with a number of specific fisheries targeting this species especially Hawaii, Australia and to the east of Japan. Are seasonal in WSP.</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC - ongoing catch and effort data collection and AFMA (Australia) and NIWA (NZ).</li> </ul>		
<b>Pole-and-line</b>	<ul style="list-style-type: none"> <li>Not caught (Bailey, Williams &amp; Itano 1996).</li> </ul>			
<b>Purse seine</b>	<ul style="list-style-type: none"> <li>Occur only rarely in the WTP and in 0.3% of sets in NZ EEZ (Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC - ongoing catch and effort data collection and AFMA (Australia) and NIWA (NZ).</li> </ul>		
<b>Troll</b>	<ul style="list-style-type: none"> <li>Not caught (Bailey, Williams &amp; Itano 1996).</li> </ul>	<ul style="list-style-type: none"> <li>SPC &amp; IATTC - ongoing catch and effort data collection and AFMA (Australia) and NIWA (NZ).</li> </ul>		
<b>Recreational</b>	<ul style="list-style-type: none"> <li>Fairly minor gamefish species, though increasing in popularity off USA, NZ and Australia.</li> <li>Total recreational catch unknown, but is probably in the 10s-100 tonnes.</li> </ul>	<ul style="list-style-type: none"> <li>Minimal data collected by gamefishing clubs</li> </ul>	<ul style="list-style-type: none"> <li>SPC trying to coordinate collection – all assistance appreciated</li> </ul>	
<b>Recruitment</b>	<ul style="list-style-type: none"> <li>Little is known re their movement though there is a general west to east movement from Hawaii to North America (WPRFMC 1998). Also there is evidence (DeMartini<sup>3</sup>) that catch may be related to increased food availability.</li> <li>There have also been reports of very small fish caught by game-fishermen and longliners off eastern Australia.</li> </ul>	<ul style="list-style-type: none"> <li>SPC –ongoing catch and effort data collection. NMFS?</li> </ul>	<ul style="list-style-type: none"> <li>SPC –ongoing catch and effort data collection. NMFS</li> </ul>	

<b>Broadbill swordfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Data holdings</b>				
<b>Commercial (logbook, landings, observer)</b>	<ul style="list-style-type: none"> <li>• SPC Catch and effort data back to 1962, Observer data from 1994 (limited), unloading data (from 1993) (Anon 1998).</li> <li>• AFMA logbook holdings – both domestic and foreign (1979 to present).</li> <li>• US? Western Pacific Regional Fisheries Management Council, Hawaii, 1987 to present.</li> <li>• IATTC purse seine (from 1989) and longline data back to 1952</li> </ul>	<ul style="list-style-type: none"> <li>• SPC (OFP section) is responsible for compiling regional tuna fisheries data. (Anon 1998).</li> <li>• IATTC monitoring purse seine and longline in eastern Pacific</li> </ul>	<ul style="list-style-type: none"> <li>• SPC &amp; IATTC will continue carrying out this activity</li> </ul>	<ul style="list-style-type: none"> <li>•</li> </ul>
<b>Recreational</b>	<ul style="list-style-type: none"> <li>• Some holdings within national gamefishing clubs (very limited and disjointed). Some holdings by national fisheries management bodies (even more limited)</li> </ul>	<ul style="list-style-type: none"> <li>• SPC coordinating holdings onto SPC database.</li> <li>• IATTC have proposal for data collection programme.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC coordinating with IGFA and gamefishing clubs to standardise data 'log sheet'.</li> </ul>	
<b>Research (e.g. tagging, length-weight data sets)</b>	<ul style="list-style-type: none"> <li>• SPC - length frequency &amp;/or weight data from 1991 (port sampling and observers) – total number 7,105. (SPC data). Various studies being carried out in Australia (CSIRO, AFMA, BRS)</li> </ul>	<ul style="list-style-type: none"> <li>• SPC, CSIRO, AFMA &amp; BRS ongoing</li> <li>• IATTC – stock assessment in EPO and cooperation with ISC outside EPO.</li> </ul>	<ul style="list-style-type: none"> <li>• SPC, CSIRO, AFMA &amp; BRS ongoing</li> </ul>	
<b>Biological</b>				
<b>Age and growth</b>	<ul style="list-style-type: none"> <li>• Still little agreement between researchers - can attain ages of 25 years (Ward &amp; Elscot, in press). Are major growth and age differences between males and females (Radtke and Hurley 1983; Wilson and Dean 1983). They also concluded that fish length and weights might not be good indicators of swordfish growth. Review by Sosa-Nishizaki (1997) and Ehrhardt (1996).</li> </ul>	<ul style="list-style-type: none"> <li>• CSIRO undertaking pilot study on BBL spines.</li> <li>• NMFS?</li> <li>• Taiwan study based on fin spines</li> </ul>	<ul style="list-style-type: none"> <li>• Further bomb radio carbon work being carried out by ANU.</li> </ul>	
<b>Maturation &amp; spawning (location, period, size &amp; age at maturity, fecundity, sex ratio)</b>	<ul style="list-style-type: none"> <li>• Females mature @ ~140-180cm (FFL, (Ward &amp; Elscot, in press). Only minimal information in the Pacific describing sex ratios from commercial catches. The larger swordfish are females. Anon (1985) indicates that the age at first spawning is between 4 and 5 years. Swordfish have a high reproductive capacity, and batch spawn in waters where sea surface temperature is at least 24°C.</li> <li>• Fecundity is as high as 29 million eggs for a 272kg fish (Ward &amp; Elscot, in press).</li> </ul>	<ul style="list-style-type: none"> <li>• NMFS – repro biology</li> <li>• CSIRO reproductive study for western Pacific</li> <li>• Taiwan study</li> </ul>	?	

<b>Broadbill swordfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
	<ul style="list-style-type: none"> <li>Validated Gonad index (Hinton et al. 1996).</li> <li>DeMartini (1996) and Ward &amp; Elscot (in press) have carried out reviews.</li> </ul>			
<b>Diet</b>	<ul style="list-style-type: none"> <li>Feed opportunistically on squids, fish and crustaceans (WPRFMC 1998) from surface to 900m (Anon 1985).</li> </ul>	<ul style="list-style-type: none"> <li>CSIRO – ocean colour project.</li> </ul>	?	
<b>Movement</b>	<ul style="list-style-type: none"> <li>Acoustic tagging shows daily vertical movements (deep during the day, shallow at night; Carey &amp; Robinson 1981). Holts (1998) reports both long and short distance movements for tagged broadbill suggesting potential seasonal area habitation. General movement from west to east from Hawaii to N.America (WPRFMC 1998)</li> </ul>	<ul style="list-style-type: none"> <li>Only very limited tag returns to date (6 recoveries; DeMartini 1996)</li> <li>CSIRO cooperative tagging</li> </ul>	<ul style="list-style-type: none"> <li>More analysis required! Pop-up satellite tags?</li> </ul>	
<b>mortality</b>	<ul style="list-style-type: none"> <li><b>Unknown.</b> Tag recoveries ~2.8% (Holts 1998).</li> </ul>	<ul style="list-style-type: none"> <li>Ongoing conventional recreational tagging - extremely minimal.</li> </ul>	?	
<b>Other</b>				
<b>Tagging-related mortality</b>	<ul style="list-style-type: none"> <li>Potentially high, potentially high tag-loss, tag reporting rates probably low.</li> </ul>	?	?	
<b>Survival of longline-caught fish</b>	<ul style="list-style-type: none"> <li>SPC data base indicates ~ 75% of fish are alive when caught by longline in the WteP (35–50°S) while only ~50% were alive in the WSP (10–35°S).</li> </ul>	<ul style="list-style-type: none"> <li>CSIRO, AFMA, SPC &amp; NMFS observer programmes.</li> </ul>	<ul style="list-style-type: none"> <li>SPC coordinating national observer programs</li> </ul>	
<b>Stock Status</b>				
<b>Assessment</b>	<ul style="list-style-type: none"> <li>IATTC (1999) EPO stocks not over harvested. Not able to identify if open or closed population.</li> </ul>	<ul style="list-style-type: none"> <li>NMFS (operational model)</li> <li>CSIRO (performance indicator study),</li> <li>NZ</li> <li>IATTC</li> </ul>		
<b>structure</b>	<ul style="list-style-type: none"> <li>Potentially 4 Pacific stocks (CPUE analysis); 1 in western Pacific, 1 in eastern north Pacific, 1 in eastern south Pacific and 1 east of Australia and NZ (DeMartini<sup>3</sup> unpl). Genetic studies are still being refined.</li> <li>Data inadequacies have been identified previously (Bartoo unpl) and include catch and effort data, discards, size and sex composition, and biology; stock structure, ageing and growth, reproductive data etc.</li> </ul>	<ul style="list-style-type: none"> <li>IATTC – comprehensive mtDNA study with spatial and temporal resolution design for stock identification and distribution in EPO. To be presented at billfish 2001.</li> </ul>	?	Need for multidisciplinary analysis of stock structure (DeMartini <sup>3</sup> unpl).

<b>Broadbill swordfish</b>	<b>What is known (include references)</b>	<b>Who is presently doing what?</b>	<b>Who plans to do what?</b>	<b>Priority</b>
<b>Stock size</b>	<ul style="list-style-type: none"> <li>Total Pacific catch around 20,000 tonnes p.a.</li> </ul>	<ul style="list-style-type: none"> <li>SPC –ongoing catch and effort data collection. NMFS?</li> </ul>	<ul style="list-style-type: none"> <li>SPC –ongoing catch and effort data collection. NMFS?</li> </ul>	
<b>Management</b>				
<b>Gear restrictions</b>				
<b>Area restrictions</b>	<ul style="list-style-type: none"> <li>Some area restrictions around Australia and the northern Pacific and in California, also Hawaii.</li> </ul>			
<b>Catch limits</b>				
<b>Size restrictions</b>				

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